Polyolefin membrane with integrally asymmetrical structure and process for producing such a membrane

Claims:

1. Process for producing an integrally asymmetrical hydrophobic membrane having a sponge-like, open-pored, microporous support structure and a separation layer with a denser structure compared to the support structure, the process comprising at least the steps of:
   a) preparing a homogeneous solution from a system comprising 20-90% by weight of a polymer component consisting of at least one polyolefin and 80-10% by weight of a solvent for the polymer component, wherein the system at elevated temperatures has a range in which it is present as a homogeneous solution and on cooling a critical demixing temperature, below the critical demixing temperature in the liquid state of aggregation a miscibility gap, and a solidification temperature,
   b) rendering the solution to form a shaped object, with first and second surfaces, in a die having a temperature above the critical demixing temperature,
   c) cooling the shaped object using a cooling medium, conditioned to a cooling temperature below the solidification temperature, at such a rate that a thermodynamic non-equilibrium liquid-liquid phase separation into a high-polymer-content phase and a low-polymer-content phase takes place and solidification of the high-polymer-content phase subsequently occurs when the temperature falls below the solidification temperature,
   d) possibly removing the low-polymer-content phase from the shaped object,
   characterized in that a solvent for the polymer component is selected for which, on cooling at a rate of 1°C/min, the demixing temperature of a solution of 25% by weight of the polymer component in this solvent is 10 to 70°C above the solidification temperature and that, for cooling, the shaped object is brought into contact with a liquid cooling medium that does not dissolve or react chemically with the polymer component at temperatures up to the die temperature.

2. Process according to Claim 1, characterized in that the solvent for the at least one polymer is one for which, for a solution of 25% by weight of the polymer

component in this solvent and a cooling rate of 1°C/min, the demixing temperature is 20 to 50°C above the solidification temperature.

3. Process according to Claim 2, characterized in that the solvent for the at least one polymer is one for which, for a solution of 25% by weight of the polymer component in this solvent and a cooling rate of 1°C/min, the demixing temperature is 25 to 45°C above the solidification temperature.

4. Process according to one or more of Claims 1 to 3, characterized in that the polymer component has a density of ≤ 910 kg/m^3.

5. Process according to one or more of Claims 1 to 4, characterized in that the cooling medium is a non-solvent for the polymer component that, on heating up to the boiling point of the non-solvent, does not dissolve the polymer component to form a homogeneous solution.

6. Process according to one or more of Claims 1 to 5, characterized in that the cooling medium is a liquid that is a strong non-solvent for the polymer component and is homogeneously miscible with the solvent at the cooling temperature.

7. Process according to one or more of Claims 1 to 6, characterized in that the cooling medium has a temperature that is at least 100°C below the critical demixing temperature.

8. Process according to one or more of Claims 1 to 7, characterized in that 30-60% by weight of the polymer component is dissolved in 70-40% by weight of the solvent system.

9. Process according to one or more of Claims 1 to 8, characterized in that the at least one polyolefin contained in the polymer component consists exclusively of carbon and hydrogen.

10. Process according to Claim 9, characterized in that the at least one polyolefin is a poly(4-methyl-1-pentene).

11. Process according to Claim 9, characterized in that the at least one polyolefin is a polypropylene.

12. Process according to Claim 9, characterized in that the at least one polyolefin is a mixture of a poly(4-methyl-1-pentene) and a polypropylene.

13. Process according to Claim 10, characterized in that palm nut oil, dibutyl phthalate, dioctyl phthalate, dibenzyl ether, coconut oil, or a mixture thereof is used as the solvent.

14. Process according to Claim 11, characterized in that N,N-bis(2-hydroxyethyl)tallow amine, dioctyl phthalate, or a mixture thereof is used as the solvent.

15. Process according to one or more of Claims 1 to 14 for producing a hollow-fiber membrane.

16. Hydrophobic integrally asymmetrical membrane producible by a process according to one or more of Claims 1 to 15, wherein the membrane consists substantially of at least one polyolefin, has first and second surfaces and an intermediate support layer with a sponge-like, open-pored, microporous structure and adjacent to this support layer on at least one of its surfaces a separation layer, where the separation layer is dense or has pores with an average diameter < 100 nm, the support layer is free of macrovoids, the pores in the support layer are on average substantially isotropic, and the membrane has a porosity in the range from greater than 30% to less than 75% by volume.

17. Use of the membrane produced by a process according to one or more of Claims 1 to 15 for gas separation processes.

18. Use of the membrane produced by a process according to one or more of Claims 1 to 15 for gas transfer processes.

19. Use of the membrane produced by a process according to one or more of Claims 1 to 15 for oxygenation of blood.

20. Use of the membrane according to Claim 16 for oxygenation of blood.